An Experiment in Remote Printing
or
Toward the Integration of the Internet and Telephony

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Introduction

The Internet is perhaps best described as a general-purpose infrastructure for computer-communications—it supports a variety of applications, which represent a wide range of requirements.

The international telephone network is another infrastructure, although it is used primarily for connecting special-purpose devices such as telephones and G3 facsimile printers. Though data communications environments with general-purpose computers (e.g., private networks and the Internet) build on the services of the underlying telephone infrastructure, the special-purpose devices have remained inaccessible to computer users, effectively fragmenting global communications services into special application domains such as fax and phone.

Earlier this summer, we started an experiment to see how well we could integrate the Internet and telephony infrastructures.

The first application

In order to study this problem, we decided to start by trying to integrate the e-mail and facsimile communities. Many sites cooperatively provide "remote printing" access to the international telephone network. This allows people to send facsimiles via e-mail. The Internet e-mail infrastructure takes care of all the routing, delivering the message to the appropriate remote printer server in a manner totally transparent to the user.

E-mail and facsimile are very similar applications, so this is a good starting place for our research. However, there is another important benefit: we believe that by providing easy access to remote printing recipients, enterprise-wide access is enhanced, regardless of kind of institution (e.g., commercial, educational, or government), or the size of institution (e.g., global, regional, or local). This approach at outreach allows an organization to make it easier for the "outside world" to communicate with personnel in the organization who are users of facsimile but not e-mail, such as the sales person, the university registrar, or the (elected) official.

Addressing

So, what does a facsimile recipient's address look like? Like all Internet e-mail addresses, it has two parts: `local@domain`.

The "local" part contains an indication that you are using the remote printing service, along with the identity of the recipient, e.g.,

```
remote-printer.Arlington_Hewes/Room_403
```

The "domain" part identifies the address of the facsimile device (its telephone number). Start with the "international" version of the telephone number, e.g.,

```
+1-415-968-2510
```

remove the punctuation, invert the digits, and place it under a special subdomain called `tpc.int`, e.g.,

```
0.1.5.2.8.6.9.5.1.4.1.tpc.int
```

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Putting it all together, to send to someone named "Arlington Hewes in Room 403" on the fax machine at +1-415-968-2510, you would use:

```
remote-printer.Arlington_Hewes/Room_403@0.1.5.2.8.6.9.5.1.4.1.tpc.int
```

Of course, you probably wouldn't want to type this in—your user agent should give you facility for generating the address automatically!

If an Internet site is providing access to this telephone number, the Internet will automatically route the message to that site where a cover sheet will be generated and sent along with the body of the message. Of course, if you are using *MIME* (the Internet's multimedia mail standard), then in addition to plain text, you could include formatted text, *PostScript,* and images as well.

The `tpc.int` subdomain

The key to providing this remote printing facility is to use the Internets *Domain Name System* (DNS) to provide a mapping between addresses in the telephony world (i.e., telephone numbers), and those Internet sites willing to provide access to the devices at those addresses (e.g., telephones or fax machines).

The basic idea is simple: a participating Internet site registers itself in the DNS for one or more telephone number prefixes. Since both domain names and telephone numbers are hierarchical, it's easy to do this mapping. For example, suppose a company wanted to register itself as providing access to all of its own telephone numbers. It simply takes the prefix(es) corresponding to those numbers, e.g., +1-415-336, removes the punctuation, inverts the digits, and places it under the tpc.int subdomain. For example,

```
*.6.3.3.5.1.4.1.tpc.int    IN MX 0 foo.com.
```

indicates that traffic for any number in this prefix should be directed to the Internet host `foo.com`

There are really four kinds of sites which participate in the `tpc.int` subdomain:

- Neighborhood sites
- Regional sites
- Enterprise sites
- Personal sites

A *neighborhood site* is someone who provides access to any telephone in its "local calling area." The idea being that metered access in this area is fairly inexpensive, and the site is willing to provide access as a part of their community computing environment.

A *regional site* is basically just a large neighborhood site, usually providing access to an entire country or a large part of a country, such as an area code. The interesting thing to note is that regional sites may choose to shrink or expand their cell, depending on factors such as demand and cost.

An *enterprise site* is a company or other organization that provides access solely to its own facsimile machines. They register exactly those telephone prefixes which apply to their enterprise, regardless of whether the organization is located in one area, or is a multi-national.

A *personal site* is someone who provides access to exactly one telephone number, usually one that attaches to their desktop. For remote printing, when the server gets the message, it will usually just deliver it to the owner of the desktop—via e-mail.

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